

PRELIMINARY DATA SUMMARY

November 1989

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

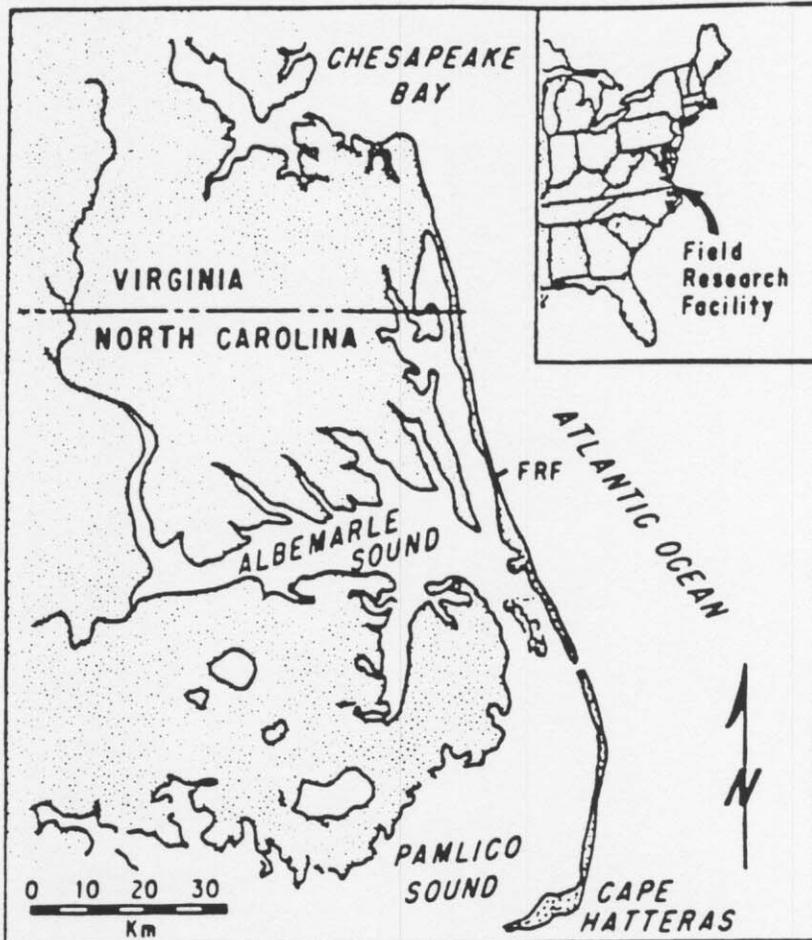


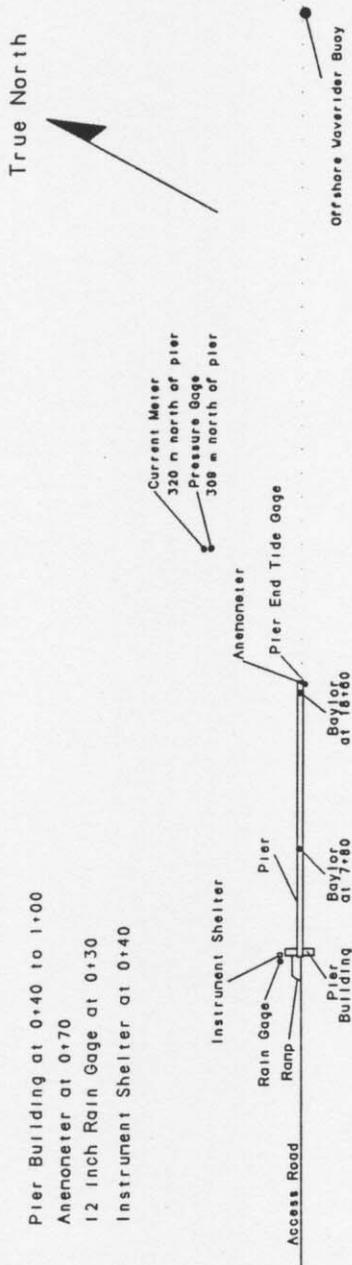
Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

NOV 1989

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3		
616	Barometric Pressure		Gage Status	*****																														
			Data Collected	*****																														
			Analog Record	*****																														
604	Precipitation		Gage Status	- - - - - Gage Inoperative - - - - -																														
			Data Collected	- - - - -																														
624	Air Temperature		Gage Status	*****																														
			Data Collected	*****																														
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*****																														
			Data Collected	***** / **** / **** / ****																														
			Analog Record	- - - - - No analog record for gage 932 - - - - -																														
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	**** / - - - - Gage Inoperative - - - - -																														
			Data Collected	**** / - - - - -																														
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	*****																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																														
			Data Collected	*****																														
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	***** / - - - - / **																														
			Data Collected	***** / - - - - / **																														
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*****																														
			Data Collected	*****																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																														
			Data Collected	*****																														
	Supplemental Observations (daily oceanographic and meteorological observations)		Daily observation	*****																														

Gage Status                      Daily Observation                      Analog Record                      Data Collected  
     Operational = \*                      Complete = \*                      Complete = \*                      All = \*  
     Partial = /                      Partial = /                      Partial = /                      Partial = /  
     Non-Operational = -                      None = -                      None = -                      None = -



Pier Building at 0+40 to 1+00  
 Anemometer at 0+70  
 12 inch Rain Gage at 0+30  
 Instrument Shelter at 0+40

CURRITUCK SOUND

ATLANTIC OCEAN

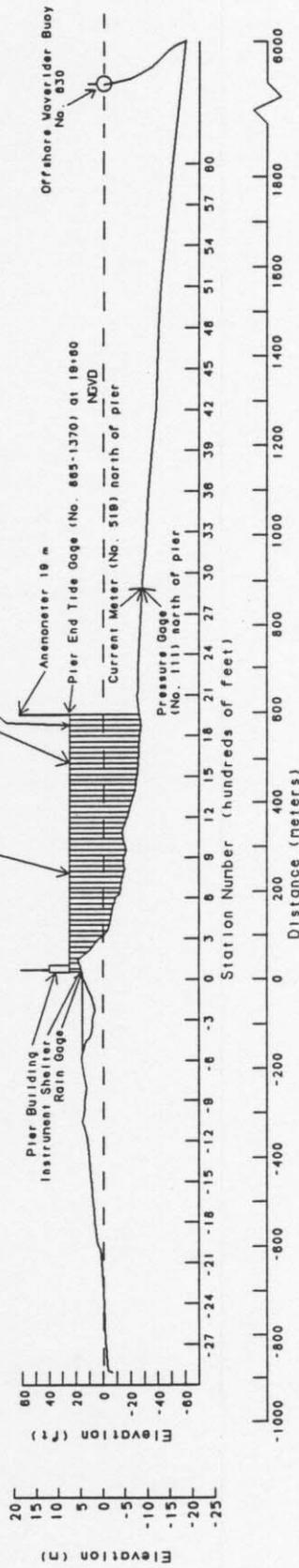


Figure 2. Instrument locations at FFR (all elevations from FFR) and NGVD (all elevations from NGVD, all distances from FFR baseline).

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Nov 1989

Day	Hour	** Wind Speed m/sec	** Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm	***
1	100	7	252	17.6	1012.5	0	
	700	2	289	16.6	1016.5	0	
	1300	3	62	19.2	1017.5	0	
	1900	7	44	16.2	1020.3	0	
2	100	7	42	15.5	1019.2	0	
	700	9	58	15.1	1018.6	0	
	1300	6	64	16.6	1016.2	0	
	1900	9	37	15.3	1014.8	0	
3	100	8	49	14.9	1009.8	0	
	700	10	326	12.1	1011.4	12	
	1300	7	327	15.7	1012.8	0	
	1900	10	350	13.7	1017.2	0	
4	100	9	10	11.5	1020.6	0	
	700	6	42	11.1	1023.3	0	
	1300	4	32	13.2	1021.9	0	
	1900	6	82	13.1	1021.3	0	
5	100	5	55	14.5	1021.3	0	
	700	6	44	15.0	1021.9	0	
	1300	5	65	16.7	1022.6	0	
	1900	3	68	15.0	1022.3	0	
6	100	2	149	13.5	1020.3	0	
	700	3	222	14.4	1019.2	0	
	1300	3	245	20.7	1015.9	0	
	1900	4	208	18.7	1015.2	0	
7	100	3	204	17.6	1014.8	0	
	700	2	262	15.7	1014.5	0	
	1300	2	119	19.7	1011.8	0	
	1900	6	248	19.0	1010.8	0	
8	100	4	212	17.6	1010.8	0	
	700	3	209	17.7	1010.4	0	
	1300		*	20.6	1008.1	0	
	1900	8	95	19.5	1007.7	0	
9	100	6	1	18.9	1006.4	0	
	700	18	47	20.0	1004.7	6	
	1300	7	204	21.0	1000.3	0	
	1900	2	291	18.0	1003.0	0	
10	100	7	307	14.4	1007.0	0	
	700	3	287	12.2	1009.8	13	
	1300	9	217	18.3	1007.7	0	
	1900	7	332	14.7	1012.5	0	
11	100	6	3	14.5	1015.5	0	
	700	5	74	13.0	1017.9	0	
	1300	5	133	16.8	1015.9	0	
	1900	5	213	15.9	1014.5	0	
12	100	9	227	16.0	1013.5	0	
	700	6	241	15.5	1015.5	0	
	1300	4	234	22.3	1016.5	0	
	1900	5	74	16.8	1020.6	0	
13	100	7	71	16.4	1023.0	0	
	700	8	84	16.5	1025.0	0	
	1300	4	132	20.2	1023.3	0	
	1900	7	157	19.1	1022.3	0	
14	100		*	18.3	1021.3	0	
	700		*	19.2	1020.9	0	
	1300	5	180	24.3	1018.6	0	
	1900	9	168	21.0	1017.9	0	
15	100	8	168	20.3	1015.9	0	
	700	4	173	18.0	1015.9	5	
	1300	7	190	23.0	1012.5	0	
	1900	7	186	19.9	1009.8	0	
16	100	10	180	20.1	1004.7	0	
	700	13	179	20.2	999.3	9	
	1300	10	247	19.0	996.9	0	
	1900	8	291	12.4	1003.7	0	

\* electronic problems

(Continued)

Table 2: Meteorological Data

Nov 1989							
Day	Hour	** Wind Speed m/sec	** Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm	***
17	100	10	285	7.5	1008.7	0	
	700	8	293	4.5	1014.5	0	
	1300	2	296	8.7	1016.5	0	
	1900	4	214	7.9	1018.6	0	
18	100	5	257	8.2	1018.9	0	
	700	6	251	8.7	1019.6	0	
	1300	6	226	11.6	1017.9	0	
	1900	6	229	11.4	1020.6	0	
19	100	9	349	9.9	1023.6	0	
	700	7	7	7.1	1026.3	0	
	1300	4	331	7.6	1025.0	0	
	1900	6	226	7.5	1022.3	0	
20	100	10	237	8.1	1017.5	0	
	700	8	223	8.3	1012.8	0	
	1300	8	214	15.3	1004.0	0	
	1900	10	221	14.9	997.6	0	
21	100	12	247	14.4	994.9	0	
	700	11	308	10.3	1002.3	0	
	1300	8	315	10.8	1005.4	0	
	1900	9	328	6.9	1011.1	0	
22	100	10	350	5.8	1014.5	0	
	700	6	318	3.5	1018.2	0	
	1300	4	87	8.4	1015.2	0	
	1900	9	48	10.5	1009.4	0	
23	100	8	352	12.5	1001.6	0	
	700	19	341	5.4	1005.0	39	
	1300	11	309	1.0	1010.4	0	
	1900	9	308	0.5	1015.9	0	
24	100	8	308	-0.1	1019.2	0	
	700	6	306	-0.1	1023.6	0	
	1300	5	309	4.4	1024.3	0	
	1900	2	214	1.5	1026.0	0	
25	100	3	201	1.7	1025.3	0	
	700	3	205	3.3	1024.7	0	
	1300	6	231	9.5	1020.6	0	
	1900	6	189	7.9	1018.6	0	
26	100	5	211	8.3	1015.9	0	
	700	7	213	11.4	1013.1	0	
	1300	9	251	16.4	1010.4	0	
	1900	4	248	11.6	1013.8	0	
27	100	8	18	13.2	1016.5	0	
	700	8	56	12.7	1019.2	0	
	1300		*	13.7	1019.2	0	
	1900	6	102	14.7	1017.5	0	
28	100	8	178	16.6	1014.8	0	
	700	6	205	15.4	1011.4	0	
	1300	7	223	18.6	1008.1	0	
	1900	7	237	15.6	1009.4	0	
29	100	13	357	12.5	1012.8	0	
	700	12	359	9.4	1014.8	0	
	1300	13	343	7.9	1016.2	0	
	1900	9	356	6.5	1019.9	0	
30	100	7	319	3.2	1019.2	0	
	700	4	280	2.0	1018.2	0	
	1300	9	250	9.0	1014.2	0	
	1900	7	235	8.4	1014.5	0	
		<u>Resultant</u>		<u>Mean</u>	<u>Mean</u>	<u>Total</u>	
		2	292	13.2	1014.9	84	

\* electronic problems

(Sheet 2 of 2)

\*\* Anemometer at end of pier used (gage No. 932)

\*\*\* Precipitation data was read daily from backup gage

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Nov 1989

Day	Hour	645 Baylor at 7+80		625 Baylor at 18+60		111 Pressure Gage		630 Offshr Wvrdr	
		Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec
1	0100	0.72	9.48	1.25	9.48	1.17	9.14	1.78	9.48
	0700	0.64	9.14	1.10	8.53	1.16	9.14	1.25	9.14
	1300	0.47	8.83	0.78	8.53	0.78	8.26	0.85	9.14
	1900	0.53	8.53	0.89	8.83	0.89	8.26	1.06	8.53
2	0100	0.69	4.00	1.03	8.26	1.01	8.26	1.04	8.53
	0700	0.80	4.74	1.10	9.14	1.11	8.26	1.26	7.76
	1300	0.77	4.83	1.02	4.74	1.05	4.74	1.16	4.74
	1900	0.72	4.66	0.97	8.83	0.97	4.66	1.13	4.49
3	0100	0.90	4.49	1.20	4.66	1.27	4.27	1.28	4.49
	0700	0.77	4.41	0.98	6.40	1.03	4.57	1.19	6.74
	1300	0.61	5.33	0.79	5.22	0.81	16.00	0.97	5.02
	1900	0.60	5.45	0.92	5.57	0.94	5.33	1.00	5.45
4	0100	0.88	5.82	1.12	5.69	1.19	5.82	1.27	6.09
	0700	0.76	5.82	1.10	14.22	1.09	13.47	1.30	6.24
	1300	0.57	14.22	1.10	14.22	1.12	12.80	1.14	14.22
	1900	0.73	13.47	1.20	13.47	1.29	13.47	1.19	13.47
5	0100	0.64	13.47	1.15	13.47	0.97	13.47	1.06	12.80
	0700	0.60	12.80	1.00	12.80	0.98	11.64	0.97	12.80
	1300	0.50	12.19	0.99	12.80	0.94	12.19	1.03	12.19
	1900	0.48	12.19	0.92	12.19	0.91	12.19	0.93	12.19
6	0100	*		0.79	11.64	0.88	11.64	0.82	11.64
	0700	0.41	11.64	0.75	11.64	0.79	11.13	0.78	11.13
	1300	0.32	11.13	0.64	10.67	0.68	11.13	0.71	11.13
	1900	0.22	10.24	0.56	11.13	0.60	10.67	0.58	10.24
7	0100			0.52	10.67	0.56	10.24	0.58	10.24
	0700			0.48	10.24	0.52	9.85	0.57	9.48
	1300			0.47	10.24	0.53	9.85	0.54	9.85
	1900			0.49	9.85	0.50	9.48	0.58	9.85
8	0100			0.43	9.85	0.47	9.14	0.49	9.14
	0700			0.44	9.14	0.47	8.83	0.55	9.48
	1300			0.44	8.83	0.46	9.48	0.58	8.83
	1900			0.42	9.48	0.43	8.26	0.49	9.85
9	0100			0.42	8.83	0.42	9.48	0.59	8.83
	0700			0.52	9.48	0.49	10.24	0.65	9.48
	1300			0.69	9.85	0.76	9.48	0.89	9.14
	1900			0.63	9.48	0.67	7.53	0.86	7.53
10	0100			0.62	8.83	0.62	9.14	0.82	8.83
	0700			0.59	9.14	0.62	8.83	0.70	9.14
	1300			0.55	8.83	0.59	8.83	0.74	9.14
	1900			0.50	9.14	0.52	9.14	0.66	10.24
11	0100	Gage Inoperative		0.76	4.41	0.78	4.34	0.84	4.41
	0700			0.78	5.02	0.76	4.57	0.91	4.74
	1300			0.73	5.33	0.69	5.45	0.73	5.12
	1900			0.46	13.47	0.47	10.24	0.51	10.67
12	0100			0.37	9.85	0.39	9.48	0.50	9.48
	0700			0.33	14.22	0.35	15.06	0.43	16.00
	1300			0.34	15.06	0.37	16.00	0.35	15.06
	1900			0.43	14.22	0.37	15.06	0.43	15.06
13	0100			0.66	3.33	0.66	3.61	0.65	3.41
	0700			0.81	3.88	0.76	4.13	0.82	4.00
	1300			0.84	4.41	0.86	4.66	0.91	4.66
	1900			0.67	5.33	0.71	5.12	0.75	5.69
14	0100			0.56	4.83	0.60	9.48	0.67	4.57
	0700			0.69	5.69	0.76	5.12	0.82	5.33
	1300			0.56	5.95	0.64	5.69	0.76	5.69
	1900			0.60	5.57	0.63	5.33	0.73	5.22
15	0100			0.78	5.95	0.83	5.57	0.96	5.95
	0700			0.88	6.24	1.03	5.95	1.01	6.24
	1300			0.66	6.24	0.69	6.09	0.83	5.95
	1900			0.69	6.74	0.77	6.24	0.94	6.09
16	0100			0.79	7.31	0.74	6.74	1.09	7.11
	0700			1.40	8.26	1.51	8.26	1.86	7.31
	1300			0.96	8.26	1.03	9.14	1.40	9.48
	1900			0.73	9.48	0.74	9.48	1.03	9.85

\* Electronic problems

(Continued)

(Sheet 1 of 2)

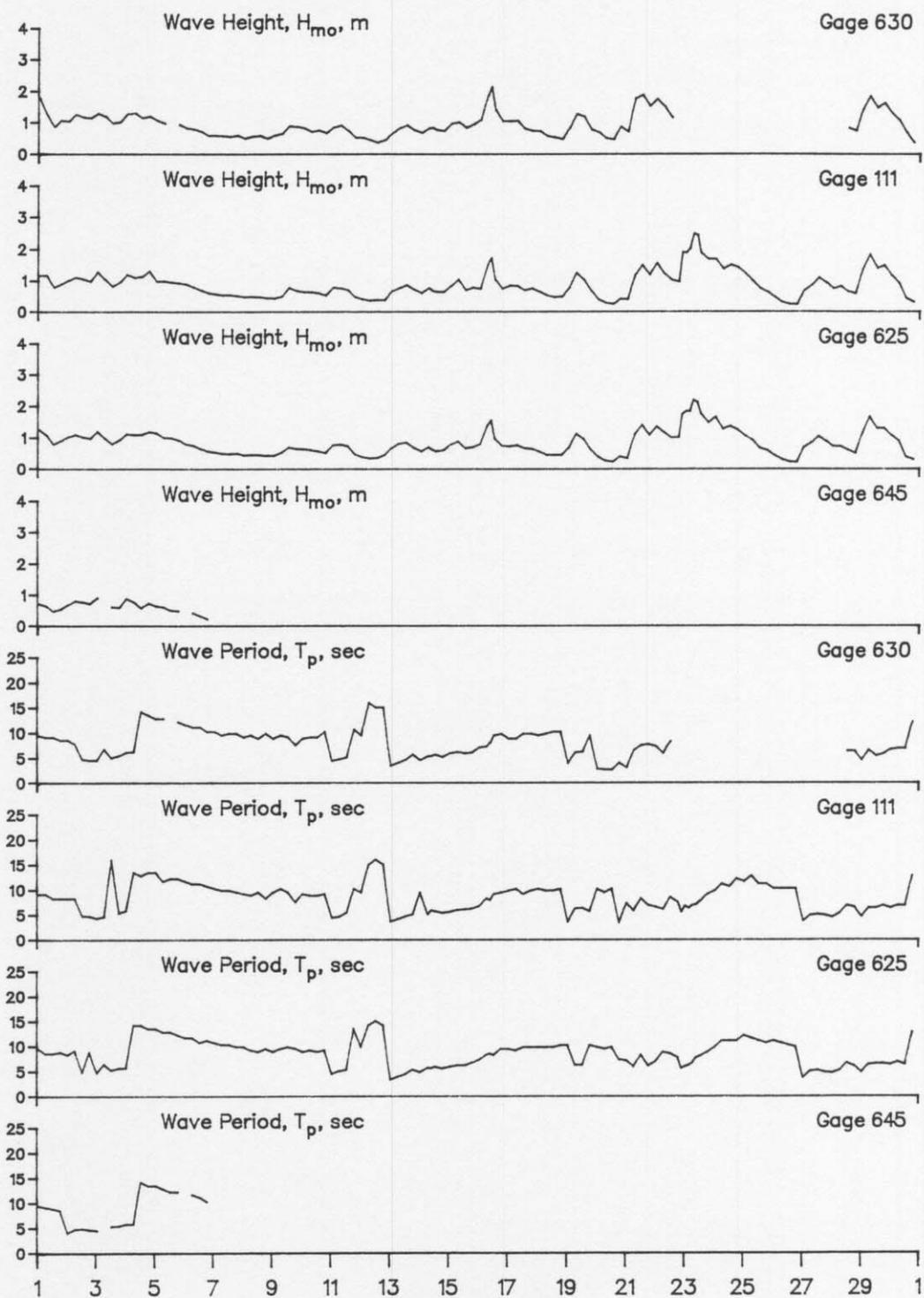
Table 3: Wave Data

Nov 1989

Day	Hour	645 Baylor at 7+80		625 Baylor at 18+60		111 Pressure Gage		630 Offshr Wvrdr	
		Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec
17	0100			0.71	9.48	0.83	9.85	1.03	8.83
	0700			0.75	9.14	0.82	10.24	1.04	8.83
	1300			0.65	9.85	0.68	9.14	0.79	9.85
	1900			0.62	9.85	0.74	9.85	0.72	9.85
18	0100			0.54	9.85	0.62	10.24	0.71	9.48
	0700			0.44	9.85	0.51	9.85	0.56	9.85
	1300			0.44	9.85	0.45	9.85	0.51	10.24
	1900			0.44	10.24	0.47	10.24	0.46	10.24
19	0100			0.68	10.24	0.76	3.56	0.82	3.94
	0700			1.12	6.24	1.24	6.24	1.27	6.09
	1300			0.96	6.24	1.02	6.40	1.18	6.24
	1900			0.61	10.24	0.67	5.69	0.77	9.48
20	0100			0.38	9.85	0.38	10.24	0.68	2.78
	0700			0.25	9.48	0.27	9.48	0.49	2.64
	1300			0.22	9.85	0.23	10.24	0.46	2.59
	1900			0.39	7.31	0.41	3.41	0.86	4.00
21	0100			0.34	7.11	0.40	7.31	0.70	3.05
	0700			1.11	5.95	1.16	5.82	1.76	6.56
	1300			1.40	8.26	1.48	8.26	1.87	7.53
	1900			1.09	6.09	1.18	6.92	1.52	7.76
22	0100			1.35	6.92	1.54	6.56	1.74	7.31
	0700			1.17	8.83	1.21	6.09	1.50	5.95
	1300			1.00	8.53	1.01	8.53	1.15	8.26
	1900			1.00	7.76	0.94	7.53		*
23	0100			1.83	5.95	1.89	6.74		*
	0700			2.19	6.74	2.48	6.92		*
	1300			1.74	8.00	1.87	7.76		*
	1900			1.48	8.83	1.67	9.14		*
24	0100			1.64	9.85	1.66	9.85		*
	0700			1.26	11.13	1.36	11.13		*
	1300			1.35	11.13	1.48	10.67		*
	1900			1.24	11.13	1.41	12.19		*
25	0100			1.05	12.19	1.21	11.64		*
	0700			0.91	11.64	0.97	12.80		*
	1300			0.65	11.13	0.74	11.13		*
	1900			0.58	10.67	0.62	11.13		*
26	0100			0.42	11.13	0.46	10.24		*
	0700			0.29	10.67	0.30	10.24		*
	1300			0.22	10.24	0.23	10.24		*
	1900			0.21	9.85	0.23	10.24		*
27	0100			0.69	3.71	0.68	3.71		*
	0700			0.83	5.02	0.85	4.92		*
	1300			1.04	5.22	1.07	5.12		*
	1900			0.89	4.83	0.93	4.92		*
28	0100			0.72	4.66	0.74	4.49		*
	0700			0.71	5.22	0.81	5.33		*
	1300			0.60	6.74	0.63	6.92	0.83	6.40
	1900			0.50	6.09	0.57	6.56	0.74	6.40
29	0100			1.15	4.83	1.36	4.57	1.43	4.57
	0700			1.66	6.40	1.83	6.40	1.84	6.56
	1300			1.29	6.56	1.39	6.40	1.47	5.45
	1900			1.29	6.56	1.47	6.92	1.62	5.82
30	0100			1.06	6.40	1.14	6.40	1.29	6.74
	0700			0.89	6.92	0.92	6.92	1.07	6.92
	1300			0.37	6.40	0.42	6.92	0.69	6.92
	1900			0.30	12.80	0.31	12.80	0.36	12.19
	Mean	0.62	8.56	0.81	8.57	0.85	8.43	0.93	7.97
	Std dev	0.17	3.48	0.37	2.70	0.40	2.85	0.36	2.93

\* Electronic problems

(Sheet 2 of 2)



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#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Nov 1989

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)		Dye 12m offshore (surface)			Speed	Dir
		Speed	Dir	Speed	Dir	Location	Speed	Dir	Speed	Dir	
1	0100-Along Cross Result								22 9 24	S off 138	
1	0700-Along Cross Result	3 1 3	S on 171	213	11 4 11	on 318	South	7 N	9 9 13	S off 115	
1	1300-Along Cross Result								13 4 14	S off 143	
1	1900-Along Cross Result								13 7 15	S off 132	
2	0100-Along Cross Result								22 9 24	S off 138	
2	0700-Along Cross Result	11 1 11	S on 166	244	4 1 4	S on 171	South	41 N	12 6 13	S off 133	
2	1300-Along Cross Result								19 10 21	S off 132	
2	1900-Along Cross Result								29 15 33	S off 133	
3	0100-Along Cross Result								29 14 32	S off 134	
3	0700-Along Cross Result	61 9 62	S off 151	238	30 9 32	S off 143	North	36 S	22 13 26	S off 129	
3	1300-Along Cross Result								24 12 27	S off 133	
3	1900-Along Cross Result								23 11 25	S off 134	
4	0100-Along Cross Result								24 9 26	S off 139	
4	0700-Along Cross Result	41 4 41	S off 154	262	6 1 6	S off 149	North	36 S	24 9 26	S off 139	
4	1300-Along Cross Result								27 18 32	S off 126	
4	1900-Along Cross Result								7 5 9	S off 124	
5	0100-Along Cross Result								7 2 7	S off 144	
5	0700-Along Cross Result	14 3 14	S on 171	238	0 2 2	on 250	South	30 S	6 7 9	S off 111	
5	1300-Along Cross Result								5 1 5	N on 329	
5	1900-Along Cross Result								4 0 4	N off 340	

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Nov 1989

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed
6	0100-Along Cross Result								1 1 1	N off 25
6	0700-Along Cross Result	34 7 35	N off 351	140	76 8 77	N off 346	South	15 N	11 4 12	N on 320
6	1300-Along Cross Result								13 6 14	N on 315
6	1900-Along Cross Result								8 0 8	N  340
7	0100-Along Cross Result								5 2 5	N on 318
7	0700-Along Cross Result	11 2 11	N on 331	152	102 10 102	N off 346	South	17 N	8 2 8	N on 326
7	1300-Along Cross Result								12 5 13	N on 317
7	1900-Along Cross Result								3 1 3	S on 178
8	0100-Along Cross Result								2 1 2	N on 313
8	0700-Along Cross Result	16 2 16	N off 349	140	87 0 87	N  340	South	27 N	1 1 1	S off 115
8	1300-Along Cross Result								14 3 14	N on 328
8	1900-Along Cross Result								4 2 4	N on 313
9	0100-Along Cross Result								5 9 10	N on 279
9	0700-Along Cross Result	38 8 39	N off 351	152	87 0 87	N  340	South	63 N	5 3 6	N on 309
9	1300-Along Cross Result								19 9 21	N on 315
9	1900-Along Cross Result								5 4 6	N on 301
10	0100-Along Cross Result								7 3 8	S off 137
10	0700-Along Cross Result	9 7 11	S off 123	165	38 8 39	N on 329	South	16 N	14 6 15	S off 137
10	1300-Along Cross Result								6 5 8	N on 300
10	1900-Along Cross Result								5 1 5	N on 329

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Nov 1989

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
11	0100	Along Cross Result									4 2 4	S off 133
11	0700	Along Cross Result	5 2 5	S on 182	152	61 6 61	N off 346	30 N	North	7 5 9	S off 124	
11	1300	Along Cross Result								12 3 12	N off 354	
11	1900	Along Cross Result								8 9 12	N on 292	
12	0100	Along Cross Result								16 8 18	N on 313	
12	0700	Along Cross Result	0 10 10	off 70	152	55 6 56	N off 346		no observation	12 5 13	N on 317	
12	1300	Along Cross Result								8 7 11	N on 299	
12	1900	Along Cross Result								3 0 3	N  340	
13	0100	Along Cross Result								0 0 0		
13	0700	Along Cross Result	4 1 5	N on 323	152	76 8 77	N off 346	30 N	South	6 2 6	N off 358	
13	1300	Along Cross Result								4 2 4	N off 7	
13	1900	Along Cross Result								6 7 9	N on 291	
14	0100	Along Cross Result								11 5 12	N on 316	
14	0700	Along Cross Result	30 3 31	N off 346	140	41 4 41	N off 346	51 N	South	15 6 16	N on 318	
14	1300	Along Cross Result								8 5 9	N on 308	
14	1900	Along Cross Result								13 5 14	N on 319	
15	0100	Along Cross Result								14 4 15	N on 324	
15	0700	Along Cross Result	28 8 29	N off 357	140	51 13 52	N on 326	48 N	South	17 7 18	N on 318	
15	1300	Along Cross Result								6 6 8	N on 295	
15	1900	Along Cross Result								9 5 10	N on 311	

KEY = All speeds in cm/sec  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Nov 1989

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir	
16	0100	Along								9	N	
		Cross								2	on	
		Result								9	327	
16	0700	Along	76	N						32	N	
		Cross	8	off	140	122	N	102	N	13	on	
		Result	77	346		123	334	South		35	318	
16	1300	Along								18	N	
		Cross								9	on	
		Result								20	313	
16	1900	Along								8	N	
		Cross								3	on	
		Result								9	319	
17	0100	Along								15	S	
		Cross								6	off	
		Result								16	138	
17	0700	Along	16	S		17	S		19	N	4	S
		Cross	0		140	3	off	North		1	off	
		Result	16	160		18	149			4	146	
17	1300	Along								5	S	
		Cross								6	off	
		Result								8	110	
17	1900	Along								5	N	
		Cross								2	on	
		Result								5	318	
18	0100	Along								2	N	
		Cross								0		
		Result								2	340	
18	0700	Along	15	N		18	N		25	N	14	N
		Cross	5	off	140	4	off	South		6	on	
		Result	16	357		19	351			15	317	
18	1300	Along								11	N	
		Cross								5	on	
		Result								12	316	
18	1900	Along								11	N	
		Cross								4	on	
		Result								12	320	
19	0100	Along								18	S	
		Cross								8	off	
		Result								20	136	
19	0700	Along	28	S		44	S		84	S	17	S
		Cross	4	on	152	7	on	North		8	off	
		Result	28	169		44	169			19	135	
19	1300	Along								12	S	
		Cross								9	off	
		Result								15	123	
19	1900	Along								6	S	
		Cross								4	off	
		Result								7	126	
20	0100	Along								4	N	
		Cross								1	on	
		Result								4	326	
20	0700	Along	18	N		9	N		15	N	14	N
		Cross	4	off	140	3	off	South		7	on	
		Result	18	351		9	2			16	313	
20	1300	Along								14	N	
		Cross								8	on	
		Result								16	310	
20	1900	Along								9	N	
		Cross								7	on	
		Result								11	302	

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Continued)  
Nov 1989

Day	Time	Pier Measurements				Beach Measurements			Current Meter	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		(500m Updrift)			0.9 km Offshore	
		Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Depth -5.6m (NGVD) ID #519
21	0100-Along							7	N	
	Cross							5	on	
	Result							9	304	
21	0700-Along	41	S		152	S		15	S	
	Cross	4	off	152	8	off	North	6	off	
	Result	41	154		153	157		16	138	
21	1300-Along							19	S	
	Cross							8	off	
	Result							21	137	
21	1900-Along							17	S	
	Cross							9	off	
	Result							19	132	
22	0100-Along							20	S	
	Cross							9	off	
	Result							22	136	
22	0700-Along	20	S		68	S		19	S	
	Cross	3	off	165	10	on	North	9	off	
	Result	21	151		68	169		21	135	
22	1300-Along							3	S	
	Cross							3	off	
	Result							4	115	
22	1900-Along							6	S	
	Cross							5	off	
	Result							8	120	
23	0100-Along							35	S	
	Cross							18	off	
	Result							39	133	
23	0700-Along	87	S		152	S		70	S	
	Cross	9	on	152	15	on	North	30	off	
	Result	88	166		153	166		76	137	
23	1300-Along							44	S	
	Cross							17	off	
	Result							47	139	
23	1900-Along							39	S	
	Cross							12	off	
	Result							41	143	
24	0100-Along							36	S	
	Cross							12	off	
	Result							38	142	
24	0700-Along	34	S		87	S		37	S	
	Cross	5	off	152	9	on	North	15	off	
	Result	34	151		88	166		40	138	
24	1300-Along							16	S	
	Cross							1	off	
	Result							16	156	
24	1900-Along							13	S	
	Cross							5	off	
	Result							14	139	
25	0100-Along							2	N	
	Cross							4	off	
	Result							4	43	
25	0700-Along	20	N		41	S		7	N	
	Cross	6	off	152	16	off	North	5	on	
	Result	21	357		44	138		9	304	
25	1300-Along							21	N	
	Cross							10	on	
	Result							23	315	
25	1900-Along							15	N	
	Cross							10	on	
	Result							18	306	

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

Table 4: Current Data (Concluded)  
Nov 1989

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed Dir		Dye 12m offshore (surface)			Speed	Dir
		Speed	Dir		Speed	Dir	Location	Speed	Dir	Speed	Dir
26	0100									20	N
										14	on
										24	305
26	0700	10	N		0			14	S	14	N
		12	off	140	1	off	South			11	on
		16	30		1	70				18	302
26	1300									14	N
										11	on
										18	302
26	1900									5	N
										2	on
										5	318
27	0100									11	S
										4	off
										12	140
27	0700	20	S		32	S		53	S	16	S
		4	on	140	13	on	North			7	off
		21	171		35	182				17	136
27	1300									12	S
										7	off
										14	130
27	1900									10	S
										6	off
										12	129
28	0100									4	N
										0	
										4	340
28	0700	24	S		47	N		20	N	7	N
		0	on	140	5	off	South			7	on
		24	160		47	346				10	295
28	1300									5	N
										7	on
										9	286
28	1900									3	N
										5	on
										6	281
29	0100									19	S
										8	off
										21	137
29	0700	41	S		102	S		105	S	27	S
		2	off	152	20	on	North			13	off
		41	157		104	171				30	134
29	1300									28	S
										12	off
										30	137
29	1900									30	S
										11	off
										32	140
30	0100									21	S
										9	off
										23	137
30	0700	0			12	S		51	S	5	S
		26	off	140	11	off	North			4	off
		26	70		16	118				6	121
30	1300									0	
										0	
										0	
30	1900									2	N
										0	
										2	340

KEY = All speeds in cm/sec  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore off = offshore

## PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Nov 1989

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0900	110	70		82	18.9	1.0202	3.7
2	0710	60		95	105	18.9	1.0197	1.8
3	0900	10			94	17.9	1.0188	1.2
4	0920	60	85	85	104	16.9	1.0188	0.9
5	0810	85			57	16.9	1.0195	0.9
6	0830	45	90		87	18.3	1.0214	2.4
7	0800	90			79	17.9	1.0220	3.7
8	0900	90			51	18.8	1.0237	2.1
9	0908	105		80	61	17.2	1.0242	0.9
10	0825	85	10	inoperative	47	16.7	1.0244	1.2
11	0930	25		inoperative	65	17.3	1.0246	1.5
12	1100	none	visible	inoperative	47	17.8	1.0244	1.8
13	0915	85	45		58	17.7	1.0246	0.9
14	0800	90			40	17.8	1.0244	1.5
15	0830	110			65	18.5	1.0240	0.9
16	0850	100		110	99	18.8	1.0246	0.9
17	0900	15			65	17.7	1.0247	1.8
18	1015	40			49	16.7	1.0248	1.5
19	1040	30			71	15.6	1.0251	1.5
20	0845	none	visible		37	15.0	1.0252	2.1
21	0900	40			77	16.1	1.0256	0.6
22	0745	30			96	13.4	1.0253	0.6
23	0920	30		inoperative	320	13.9	1.0224	0.3
24	0915	40	60		251	12.3	1.0220	0.3
25	1105	50	95		101	13.9	1.0233	0.9
26	1100	110			48	15.6	1.0253	1.5
27	0730	30	50		77	15.3	1.0255	0.6
28	0700	100	80		65	15.5	1.0257	0.6
29	1000	30	55	60	101	14.4	1.0254	0.6
30	0745	60	20		64	11.8	1.0252	0.6

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

# FRF Tide Heights

Nov 1989

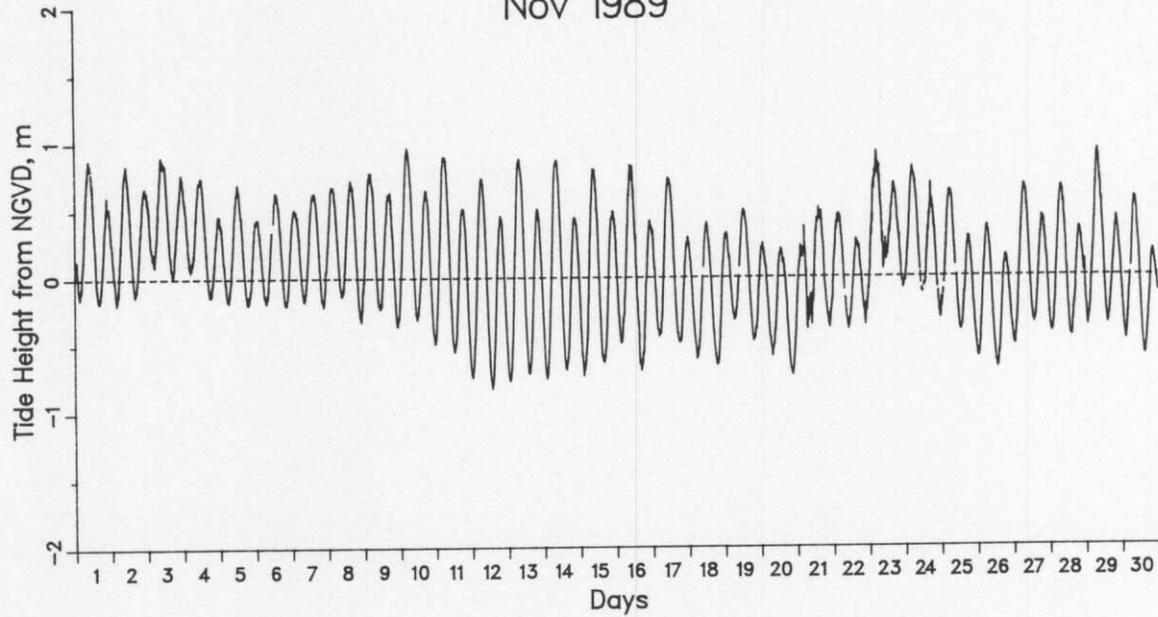


Figure 4. Water Level Time History

### Monthly Water Levels, m NGVD

Extreme Low = -0.82 on day 12 at 1236 EST  
Extreme High = 0.96 on day 10 at 406 EST  
Monthly Mean = 0.10  
Mean Low = -0.40  
Mean High = 0.59  
Mean Range = 0.99

Table 6: Water Levels, m NGVD

		Nov 1989			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	612	-0.15	0.87	0.35	1.02
1	1837	-0.18	0.61	0.17	0.78
2	703	-0.20	0.84	0.32	1.03
2	1928	-0.14	0.67	0.29	0.81
3	753	0.09	0.90	0.50	0.81
3	2018	0.01	0.77	0.38	0.76
4	843	0.05	0.75	0.38	0.70
4	2109	-0.14	0.46	0.14	0.60
5	934	-0.18	0.69	0.25	0.87
5	2159	-0.20	0.44	0.12	0.63
6	1024	-0.19	0.63	0.22	0.82
6	2249	-0.20	0.51	0.17	0.71
7	1115	-0.17	0.63	0.25	0.80
7	2340	-0.22	0.67	0.25	0.89
8	1205	-0.13	0.72	0.28	0.85
9	30	-0.33	0.78	0.25	1.10
9	1255	-0.23	0.63	0.20	0.86
10	121	-0.36	0.96	0.30	1.32
10	1346	-0.31	0.65	0.17	0.96
11	211	-0.49	0.89	0.22	1.38
11	1436	-0.55	0.51	-0.01	1.06
12	301	-0.74	0.73	0.01	1.48
12	1527	-0.82	0.46	-0.18	1.28
13	352	-0.77	0.87	0.06	1.64
13	1617	-0.71	0.51	-0.10	1.22
14	442	-0.75	0.87	0.08	1.62
14	1707	-0.69	0.44	-0.10	1.13
15	532	-0.73	0.80	0.04	1.53
15	1758	-0.63	0.49	-0.07	1.12
16	623	-0.49	0.83	0.15	1.32
16	1848	-0.69	0.42	-0.10	1.11
17	713	-0.44	0.73	0.14	1.17
17	1938	-0.48	0.30	-0.10	0.78
18	804	-0.61	0.41	-0.11	1.01
18	2029	-0.66	0.33	-0.17	0.98
19	854	-0.32	0.50	0.09	0.82
19	2119	-0.48	0.25	-0.11	0.72
20	944	-0.59	0.21	-0.18	0.80
20	2210	-0.73	0.37	-0.26	1.10
21	1035	-0.39	0.52	0.09	0.91
21	2300	-0.38	0.47	0.06	0.84
22	1125	-0.39	0.28	-0.04	0.67
22	2350	-0.36	0.92	0.24	1.28
23	1216	0.05	0.75	0.40	0.70
24	41	-0.09	0.81	0.36	0.90
24	1306				
25	131	-0.31	0.64	0.18	0.95
25	1356	-0.40	0.29	-0.05	0.69
26	222	-0.60	0.37	-0.12	0.98
26	1447	-0.68	0.16	-0.25	0.84
27	312	-0.51	0.68	0.08	1.19
27	1537	-0.35	0.45	0.05	0.80
28	402	-0.42	0.66	0.12	1.08
28	1628	-0.45	0.36	-0.04	0.80
29	453	-0.37	0.94	0.28	1.31
29	1718	-0.36	0.44	0.04	0.80
30	543	-0.47	0.58	0.06	1.05
30	1808	-0.59	0.19	-0.18	0.78

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in October and the three surveys in November on profile line 188, located 517 m south of the pier. The most dramatic changes were restricted to the nearshore (120 - 300 m) where a prominent bar (200 m) was removed then re-developed. Accretion on the foreshore (80 - 120 m) during the first half of the month was subsequently removed. In addition there was a small shoreward migration of the berm (100 m).

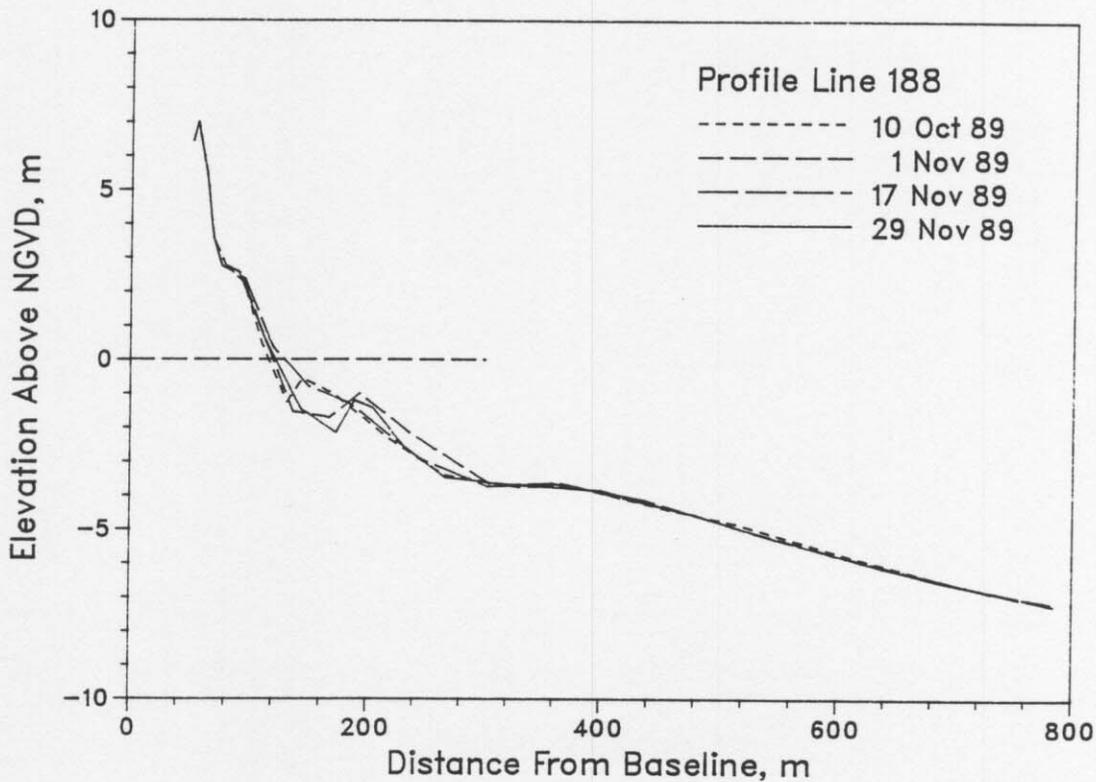


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1989. The development of the nearshore bar and the movement of the berm are responsible for the changes to the envelope.

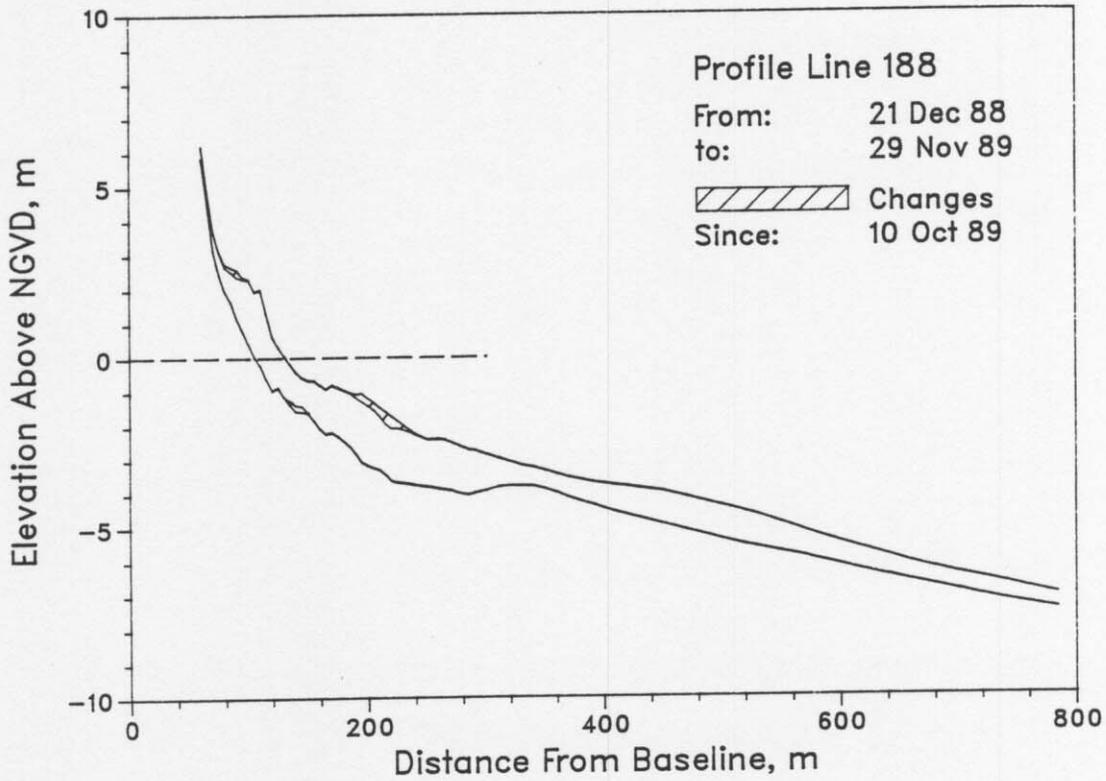


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 1 November. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

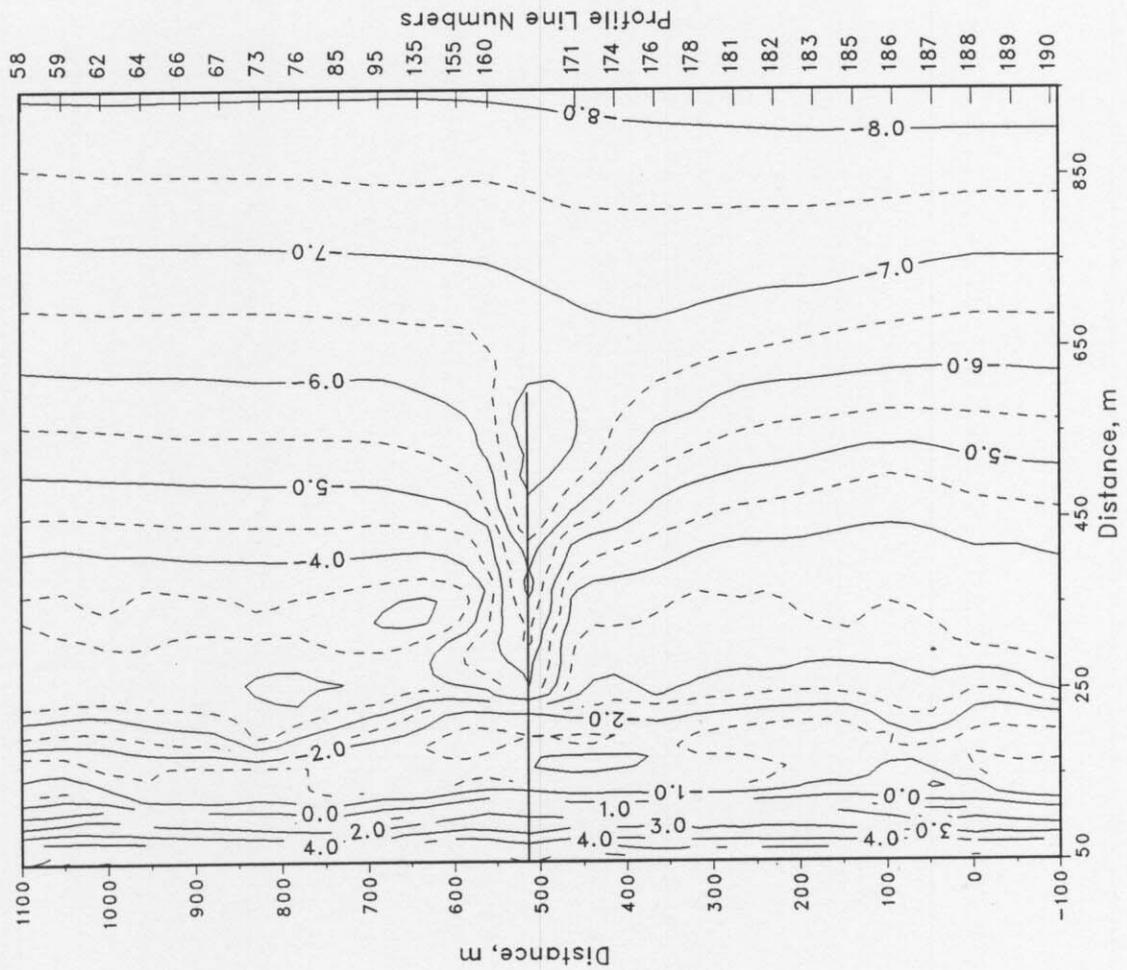
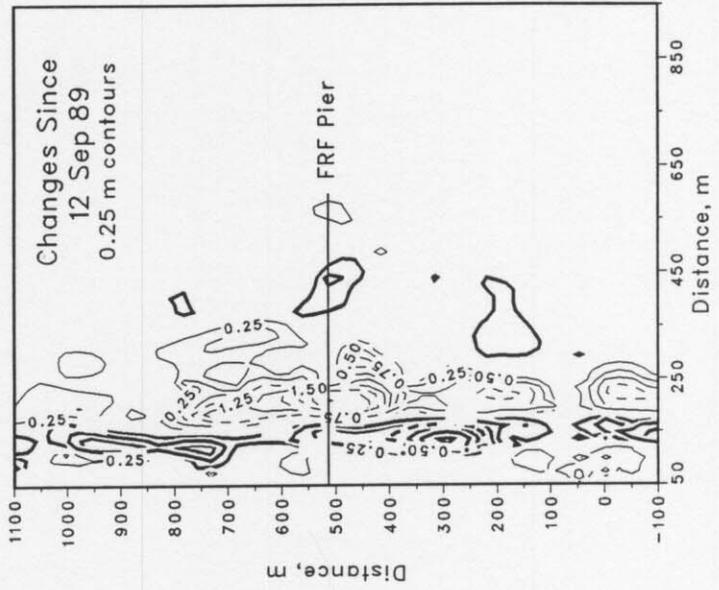
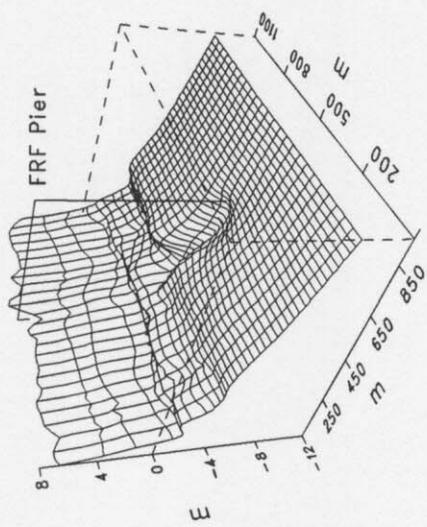


Figure 7. FRF bathymetry 1 Nov 89 depths relative to NGVD

## PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
23 Nov (0134)	23 Nov (1034)

### B. Storm Synopsis.

23 November - Developing over Texas early on 22 November this storm quickly moved to the east, being located off North Carolina on 23 November. Maximum wind speeds (from north-northwest) exceeded 19 m/s at 0542 EST on 23 November. Recorded several hours later at 0808 EST the peak  $H_{mo}$  ( $T_p = 7.31$  sec) reached 2.32 m (at gage 625). The minimum atmospheric pressure of 1000.7 mb occurred at 0134 EST, also on 23 November. Total precipitation was 39 mm.

## Distribution List

### Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

### Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

### Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
Mr. Mason	WCTI-TV
Masonite Corporation	SEASUN Power Systems

### Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)  
Queen's University, Ontario (Canada)  
Ministry of Construction, Coastal Division (Japan)  
Norwegian Hydrodynamic Laboratories (Norway)  
University of New South Wales (Australia)  
University of Sydney (Australia)